National Aeronautics and Space Administration

Technology Opportunity

Technology Transfer & Partnership Office

TOP3–00209

Wind Tunnels at Glenn

Facility

Glenn Research Center has six unique world-class wind tunnels with varying capabilities.

Facility Description

The **1- by 1-Foot Supersonic Wind Tunnel** specializes in conducting fundamental research in supersonic and hypersonic fluid mechanics, supersonic-vehicle-focused research, and detailed benchmark quality experiments for computational fluid dynamics. This facility is an excellent low-cost testing tool for small-scale research.

The **8- by 6-Foot Supersonic Wind Tunnel** is a world-class test facility that provides researchers the opportunity to explore subsonic, transonic, and supersonic speed range. The facility tests advanced aircraft concepts and components, engines for high-speed aircraft, and launch vehicle concepts. It is NASA's only transonic propulsion wind tunnel, operating from Mach 0.25 to 2.0 and at very low speeds from 0 to Mach 0.1. This facility is equipped for aerodynamic and propulsion scale models.

The **9- by 15-Foot Low-Speed Wind Tunnel** is the most utilized low-speed propulsion acoustic facility in the world specializing in evaluating aerodynamic performance and acoustic characteristics of fans, nozzles, inlets, propellers, and hot gas reingestion of advanced Short Takeoff Vertical Landing (STOVL) systems. It is the only national facility that can simulate takeoff, approach, and landing in a continuous flow wind tunnel environment.

The **10- by 10-Foot Supersonic Wind Tunnel** is the largest wind tunnel at NASA Glenn specifically designed to test supersonic propulsion components such as inlets and nozzles, propulsion system integration, and full-scale jet and rocket engines. This dual-cycle wind tunnel can operate as a closed-loop (aerodynamic cycle) or open-loop system (propulsion cycle) and is equipped for large-scale aerodynamic models as well as full-scale engine and aircraft components. This facility operates from 0 to Mach 0.36 and Mach 2.0 to 3.5.

The **Icing Research Tunnel (IRT)** is one of the world's largest refrigerated wind tunnels dedicated to the study of aircraft icing. In this facility, natural icing conditions are duplicated to test the effects of in-flight icing on actual aircraft components and models of aircraft, including helicopters.

The **Hypersonic Tunnel Facility (HTF)** tests large-scale hypersonic air-breathing propulsion systems. The HTF is a hypersonic (Mach 5, 6, 7) blowdown, nonvitiated (clean air) windtunnel capable of testing large-scale propulsion systems at true enthalpy flight conditions.

Facility Benefits

- Provides aerodynamic and propulsion test capabilities from low subsonic through high supersonic Mach range
- Standardized data acquisition systems
- Accommodates in-house and private industry research programs
- Experienced staff of technicians, engineers, researchers, and operators
- High customer satisfaction

Commercial Applications

- Supersonic and hypersonic fluid mechanics
- Aircraft and missile developments
- Next-generation launch vehicles
- Jet and rocket engines
- Inlet performance and operability
- Propulsion system integration
- Engine and fan noise reduction
- Low-speed flight applications
- Advanced propulsion system components
- High-speed and counterrotating fans
- Airport noise
- Provides next-generation ice protection systems for military and commercial aircraft

Programs and Projects Supported

- High-Speed Civil Transport
- National Aerospace Plane (NASP)
- Space Shuttle
- Joint Strike Fighter (JSF)
- Aviation Society Program
- Integrated system test on air-breathing rocket (ISTAR) direct connect combustion rig test

Facility Testing Information

http://facilities.grc.nasa.gov

Capabilities

Icing Research Tunnel

Test section dimensions, ft Height Width Length	 6 9 20
Liquid water content, LWC, g/m^3	0.2 to 3.0
Drop size, MVD, μm	15 to 50
Uniform icing cloud dimensions, ft	4.5 by 6
Cloud uniformity, percent LWC	±20
Test section air velocity, KTS	50 to 350
Test section total temperature, ˚F	–25 to +40
Simulated engine flow lb/s	1 to 85
Heated auxiliary air (bleed simulation) (at 900 ˚F and 120 psig), lb/s	1

Contacts

David E. Stark, 8×6, 9×15, and 10×10 Facility Manager
NASA Glenn Research Center
Phone: 216–433–2922
Fax: 216–433–8551
E-mail: David.E.Stark@nasa.gov

Gwynn A. Severt, 1×1 Facility Manager
NASA Glenn Research Center
Phone: 216–433–8310
Fax: 216–433–8551
E-mail: Gwynn.A.Severt@nasa.gov

John F. Leone, IRT Facility Manager
NASA Glenn Research Center
Phone: 216–433–5722
Fax: 216–433–8551
E-mail: John.F.Leone@nasa.gov

Brian P. Willis, HTF Facility Manager
Plum Brook Station
NASA Glenn Research Center
Phone: 419–621–3202
Fax: 419–621–3236
E-mail: Brian.P.Willis@nasa.gov

Technology Transfer & Partnership Office
E-mail: ttp@grc.nasa.gov
http://technology.grc.nasa.gov

Propulsion Wind Tunnels—10×10, 9×15, 8×6, 1×1, HTF (Plum Brook)

	10×10 Supersonic		9×15 Low speed	8×6 Supersonic	1×1 Supersonic	HTF (Plum Brook)
	Aero Cycle	Propulsion Cycle				
Test section speed, Mach	0 to 0.36 and 2.0 to 3.5		0.0 to 0.23 (0 to 150 KTS) (0 to 175 mph)	0 to 0.1 0.25 to 2.0	1.3,1.6, 2.0, 2.5, 2.8, 3.0, 3.5, 4.0, 5.0, 5.5, 6.0	Free-jet 5,6,7
Simulated alt., ft	50,000 to 154,000	57,000 to 77,000	Sea level	1,000 to 35,000	11,000 to 115,000	68,000 to 120,000
Test section Reynolds no./per ft	.12×10^6 to 3.4×10^6	2.2×10^6 to 2.7×10^6	0 to 1.4×10^6	3.6×10^6 to 4.8×10^6	.4×10^6 to 16.5×10^6	.97×10^6 to 2.3×10^6
Dynamic pressure, lbf/ft$_2$	20 to 720	500 to 600	0 to 72	200 to 1,340	80 to 1,750	300 to 2,200
Test section total temperature, ˚R	540 to 750	520 to 1,140	Ambient to 550	520 to 720	520 to 1,100	2,200 to 4,190
Auxiliary air supply At 40 psig At 150 psig At 450 psig Model exhaust	 ---------- 2 lb/s 12 lb/s Variable	 ---------- 2 lb/s 12 lb/s 20lb/s at 2 psia	 (Heated) 30 lbm/s 30 lbm/s 30 lbm/s Variable	 30 lbm/s 30 lbm/s 30 lbm/s Variable	 ---------- 2 lbm/s 8 lbm/s Variable	----------
High pressure air (2,600 psig) storage, scf	981,000	981,000	981,000	981,000	----------	675,000 GN$_2$ at 45,000 psi 386,000 GO$_2$ at 22,000 psi
Fuels	Liquid jet fuel Gaseous H$_2$ and O$_2$		Gaseous Hydrogen		----------	Liquid jet fuel Gaseous H$_2$ and O$_2$ Natural gas

M–1625–11
Jan 07